SPECTRAL MONITORING OF NGC 1365: NUCLEUS AND VARIABLE ULX

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Below we give a summary of our work and findings so far and discuss the work planned to complete this project.

There are two very interesting sources in this data set: the variable active nucleus, and a variable luminous ULX. The data, in conjunction with our previous XMM observations, allow detailed spectral and variability studies.

(1) The Nuclear Source.
A letter has been submitted to ApJ, and is in the final stages of revision on the spectral variability of the nuclear source (Risaliti et al 2005).

We presented multiple Chandra and XMM-Newton observations of the Seyfert Galaxy NGC 1365, which shows the most dramatic X-ray spectral changes observed so far in an AGN: the source switched from reflection dominated to Compton-thin and back in just 6 weeks. During this time the soft thermal component, arising from a 1-kpc region around the center, remained constant. The reflection component is constant at all timescales, and its flux is a fraction of 5% or higher of the direct 2-10 keV emission, implying the presence of thick gas covering a big fraction of the solid angle. The presence of this gas, and the fast variability time scale, suggest that the Compton-thick to Compton thin change is due to variation in the line-of-sight absorber, rather than to extreme intrinsic emission variability. We discuss a structure of the circumnuclear absorber/reflector which can explain the observed X-ray spectral and temporal properties.

But these important results come only from scratching the surface of the data, since we did not need any detailed spectral analysis to distinguish between the Compton thick and Compton thin states of the source, the difference in both spectral shape and flux being huge.

At least two more important features emerged from our preliminary analysis: We found 4 strong absorption lines at energies between 6.7 and 8.25 keV, unambigously identified as FeXXV and FeXXVI Kalpha and Kbeta lines. These are the highest signal-to-noise (by an order of magnitude) iron Kalpha absorption lines detected so far, and the first Kbeta ever detected. We already ruled out any possible instrumental errors affecting our data, and we are in the process of fitting these data with a physically acceptable model. A very high ionization of the absorber is required, and probably saturations effects play a role, since the measured line ratios are significantly different than theoretical expectations. Most of the work has still to be done: modeling with atomic codes such as XSTAR are needed, and a physical model for this hot gas has to be worked out. Also, we will compare our results with the average X-ray spectral properties of Seyferts, in order to investigate why these strong lines are only detected in NGC 1365. Several questions are open: is this suorce intrinscally peculiar? Are the absorption lines due to orientation effects? How many other sources have been observed with enough statistics to tell whether such lines are present?

The X-ray light curves show a significant variability during the 2 60-ksec observations. We computed hardness ratio light curves, in order to check whether the variations are only in flux or the spectral shape is also changing. In both cases we found a strong variability in spectral shape. For the first 60 ksec observations we made a preliminary spectral analysis of three time intervals of ~20 ksec each, finding evidence of variations in the absorbing column density. If confirmed, this would be the fastest column density variability observed so far, implying an extremely compact size for the X-ray absorber. This result needs to be confirmed through a careful analysis which takes into account the degeneracy among the spectral parameters, in order to rule out other possible sources of variability (such as changes in the continuum slope). Finally, this analysis has to be repeated for the second 60 ksec observation. Once the final data are available, we will use them to constrain the geometry and the composition of the circumnuclear absorber, so testing the Unified Model for AGNs.

(2) The ULX NGC1365 X-1.
This ULX is one of the few reported reaching X-ray luminosities near 10**40 erg/s, and as such is a good IMBH candidate. The ULX was seen to vary in the ROSAT data. We now have 6 new observations (1 archival Chandra observation and 5 observations we have obtained with XMM) to study in detail the spectral variability properties of this source. We observe a factor 4 variability among the XMM observation, with a peak luminosity ~9 x 10**39 ergs/s. There is also evidence of variability in the X-ray colors and spectral parameters. The last two XMM exposure of 60 ks each demonstrate that a simple power-law spectrum is not a good fit to the data, suggesting in both instances soft excesses, with possibly different temperatures. We need to explore in more detail the luminosity color and spectral parameter behavior in the XMM data, and then summarize the results and interpretation in a paper.